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H8 A4

MEASUREMENT OF THE EFFECT OF A 115-KV TRANSMISSION LINE ON THE ELECTRIC AND MAGNETIC FIELD ENVIRONMENT IN AND AROUND A PUBLIC SCHOOL

S.M. Harvey

In response to a request from the Waterloo County School Board, electric and magnetic fields produced by a double-circuit 115-kV transmission line in and around a new public school adjacent to the line were measured. Measurements were also made to compare the power-frequency magnetic field environment at this school with the power-frequency magnetic field environment of an older school located some distance from the line. The electric and magnetic field environments are well below all present and projected guidelines and are within the range expected in and around typical residential or institutional buildings. The magnetic field levels are determined mainly by the low-voltage school wiring. In particular, the transmission line adjacent to the new school had no significant effect on either the range or the complexity of the magnetic field environment at the new school in comparison with the older one.

1. INTRODUCTION

Because of parental concerns about the close proximity of a new public school to an Ontario Hydro transmission line, The Waterloo County School Board requested, through Ontario Hydro's Community Relations Department, that Ontario Hydro carry out some measurements of power-frequency electric and magnetic fields at this school. Measurements were also requested, for comparison purposes, at a similar school not located close to a transmission line.

job	file	date	report no.
16-224	817.22	October 27, 1987	87-237-K

Mary Johnston Public School is located on Board-owned property adjacent to and on the north side of an Ontario Hydro transmission line. This line, known as Waterloo to Waterloo (Rush), is a double-circuit (D8S/D10H) 115-kV transmission line that was constructed and placed in service in 1962. A 13.8-kV distribution line operated by Waterloo North Hydro Commission is located on the northern boundary of the Ontario Hydro right-of-way. This line provides electrical service to the school and other customers from Eby Rush Municipal Distribution Station on Fischer-Hallman Avenue.

Measurement procedures and protocols were established in a number of meetings involving Ontario Hydro Electrical Research and Community Relations Departments, the Waterloo County School Board, Dr. D. C. Nobes of the University of Waterloo Physics Department who had been retained by the Board as a scientific advisor, and representatives of the Beechwood Ad Hoc Committee for Power Line Study, a local parent group. The schools selected were Mary Johnston Public School and Empire Public School.

The measurements were made during June and August, 1987, by the Electrical Research Department with Mr. C.E. Taylor of Community Relations, Mr A. Ewasco of the Waterloo County School Board, and Dr. Nobes in attendance and participating. The measurements are described and the results are discussed in this report. The principal finding of the study is that the electric and magnetic field environments are determined mainly by electrical usage within the schools and are typical of residential or institutional buildings. The transmission line was found not to have a significant effect on these environments.

2. A NOTE ON ELECTRIC AND MAGNETIC FIELDS

Electric and magnetic fields are associated with all electrical processes, natural or man-made. An electric field exists whenever two objects have different voltages and is easily defined if the two objects are large parallel plates. As shown in Figure 1A, the electric field between two such plates is obtained by dividing the voltage difference by the separation of the plates. If the voltage difference is 1 kilovolt (kV) and the separation is 1 meter (m), then the field is 1 kV/m.

A magnetic field exists whenever a current flows along a path and is easily defined if the path is a circular loop. As shown in Figure 1B, the magnetic field at the center of such a loop is obtained by dividing the current by the diameter of the loop. If the current is 1 Ampere (A) and the diameter is 1 m, then the field is 1 A/m.

Power-line field strengths are usually given in units of kV/m and microTesla (μT). The microTesla is slightly smaller than the A/m unit (1 A/m = 1.25 μT). Because power-line fields reverse polarity 60 times per second, closely following a mathematical sine wave, it is customary to express their field strengths in these units as a time average known as the root-mean-square (RMS) value. The RMS value of a sine wave is 71% of the peak value.

3. MEASUREMENT OBJECTIVES

In discussions between the involved parties, it was agreed that the measurements should have three objectives. The first objective was to determine the electric and magnetic field strengths produced by the nearby transmission line on the Mary Johnston School

property and in the school building. The second and third objectives, established after the above measurements were completed, involved only magnetic fields. These were to compare the magnetic field strengths in and around a functioning Mary Johnston School with those around Empire School, and to look for unusual amplitude or waveform fluctuations in the transmission line magnetic fields at Mary Johnston School.

The last objective was added at the request of the parent group. This request appears to be associated with an unpublished Swedish study involving specialized radio-frequency magnetic fields of the type produced by video display units, which are characterized by sustained rapid rates of change of magnetic field strength with time. Although the relevance of this study to power-frequency fields was not made clear, concerns were expressed that conventional RMS measurements of transmission line magnetic fields were inadequate. To address these concerns, special procedures and instruments were introduced and full documentation on measurement procedures and protocols is provided in the following sections.

4. TRANSMISSION LINE FIELD STRENGTHS

4.1 Measurement procedures and protocol

Transmission line field strengths were measured at Mary Johnston Public School on June 25th, 1987. At this time, the school building was still under construction. The structure appeared to be essentially complete but the interior services and finishing were not installed. The site was graded but still bare of vegetation. This provided an excellent opportunity to measure actual power-line fields around the site with minimal interference from power sources within the school.

The loads on the two transmission line circuits were respectively 19 megawatts (MW) and 50 MW. These loads are reported to be fairly constant throughout the year.

Power-line fields were measured following in general outline the procedures recommended by the Institute of Electrical and Electronics Engineers and the American National Standard Institute/1/. These specify, among other things, that field measurements are to be made at 1 m above grade and are to be reported in RMS values. Measurements were made on the Ontario Hydro right-of-way, under the Waterloo Hydro 13.8-kV distribution line, and at additional locations across the school property both inside and outside the school building. The measurement locations are shown in Figure 2.

Electric field strengths were measured with an Electric Field Measurement Co model 110-2-9 power-frequency field meter that had been modified to model 111-2 specifications. The model 110 and its subsequent derivations from this company are sometimes referred to as "Denometers" and are considered to be among the benchmark instruments for the measurement of power-line fields.

Magnetic field strengths were measured with an air-cored, magnetically balanced and electrostatically shielded pick-up coil built by Ontario Hydro Research Division. This coil has an essentially flat frequency response from 60 Hz to 15 kHz. For portability and use where electrical power was not available, the coil output was measured with a battery powered Beckman model RMS 3030 digital multimeter.

4.2 Measurement Results

RMS electric and magnetic field strengths measured at each of the locations shown in Figure 2 are listed in Table 1. Electric field values along a line through the school building are plotted as a function of distance from the transmission line in Figure 3, and magnetic field values along the same line are plotted in Figure 4.

The measurements show that the electric field strength starts at 0.20 kV/m at the edge of the school property and falls off quite rapidly as one moves across the property. There is no significant electric field produced by the transmission line inside the school building. The magnetic field strength starts at about 0.6 μT and again falls off rapidly as one moves across the property. The measurements suggest some additional reduction of magnetic field strength inside the school building but are not conclusive in this regard.

The measured power line field strengths outside the school are in good agreement with calculations performed by Ontario Hydro's Transmission Lines Design Department. The largest electric and magnetic field strengths inside the school building are 0.001 kV/m and 0.18 μT respectively. These occur at the south end, closest to the transmission line.

4.3 Comparative Data

In any functional building, electric and magnetic fields basically the same as those produced by transmission lines are produced by the building's own electrical plant, wiring, appliances, and so on. These internally produced fields are more variable and less predictable than transmission line fields. However, the range of field levels that will exist in various buildings can be realistically estimated from available data. Table 2 shows electric and magnetic field strengths produced in several buildings by sources within the building for comparison with the fields produced by the transmission line at Mary Johnston School.

5. SCHOOL COMPARISON

5.1 Measurement Procedures and protocol

In order to compare the magnetic field environments in the two selected public schools, measurements were made at Mary Johnston Public School on August 17th and Empire Public School on August 18th, 1987. At this time the electrical services at Mary Johnston school were largely operational, and representative lighting and ventilating loads were connected at both schools.

Both schools have 208 Volt, 3 phase, 4 wire, electrical services. For reference purposes, the electrical load at each school at the time of the measurements was recorded.

RMS Magnetic field strengths were measured at 1 m above grade or floor level, and at a number of comparable locations across both school properties both inside and outside of the school buildings. Preliminary measurements were made with a Monitor Industries model 42A exploratory AC milligaussmeter. At most locations, in view of the requirement to look for unusual fluctuations, additional measurements were made with the

Electrical Research Department pick-up coil connected to more sophisticated and less portable recording devices. These devices are itemized in the next section.

The measurements used in this report have been selected and processed to simplify the presentation. Locations for which the results have been analysed are shown in Figures 5 and 6. A more complete listing, compiled on site and supplied by Dr. Nobes, is attached as an appendix.

5.2 Measurement Results

Magnetic field strengths measured at Mary Johnston school on August 17th and at Empire school on August 18th are listed in Tables 3 and 4 and are shown graphically in Figures 7 and 8.

Figures 7 and 8 taken together show that there is no significant difference in the magnetic field profiles taken inside and outside across the two school properties except for localized areas corresponding to the main electrical wiring paths within the school buildings. Field values measured at Mary Johnston School on June 25th are replotted on Figure 7 for comparison. These figures show that the transmission line field has not changed appreciably from June to August.

Differences due to internal wiring variations are to be expected. Mary Johnston School is 30 years newer than Empire school and has more modern electrical services with higher ampacity circuits. It is also 60% larger and uses three times as much electrical power, apparently as a result of improved lighting and a more powerful, centralized, ventilating system.

The magnetic fields measured at both schools are within the normal range expected from internal and external electrical service wiring. In particular, Figures 7 and 8 show that the magnetic fields at Mary Johnston School are not increased relative to Empire School by the presence of the nearby transmission line.

6. MAGNETIC FIELD FLUCTUATIONS

6.1 Measurement Procedures and Protocol

In order to comply with the third objective, multiple-sweep photographs were obtained of the actual 60-Hz magnetic field waveform as displayed on a Tektronix model 5103N oscilloscope with a high-gain differential-input plug-in preamplifier, and waveform-averaged measurements of the harmonic frequency spectrum of the waveform were obtained with a Hewlett-Packard model 3582A signal analyser. In addition, the time variation of the RMS field strength was recorded over a period of about 5 minutes with a Hewlett-Packard model 3400A RMS voltmeter connected to a Hewlett-Packard model 680M strip-chart recorder.

These measurements were made at the edge of the transmission line right-of-way at Mary Johnston school, and were repeated at most other locations during the August 17th and 18th surveys so as to provide a basis for evaluating any fluctuations produced by the transmission line.

The photographs and the strip-chart recordings visually demonstrate any significant departures from the essentially constant-amplitude sine-wave field that is expected from transmission lines. An accepted engineering measure of the quantitative departure from an ideal sine wave is the Total Harmonic Distortion, or THD, which may be calculated from the measured harmonic frequency spectrum.

6.2 Measurement Results

The time variation and the waveform of the magnetic field at the edge of the Ontario Hydro right-of-way are shown in Figure 9. The field at this point is largely due to the transmission line with a smaller contribution from the Waterloo Hydro distribution line. No significant fluctuations or deviations from a sinusoidal waveform are observed.

The fields produced by a building's own internal wiring show greater fluctuations, either as a result of switching some of the building's electrical equipment on or off, or as a result of the distortions produced by the fluorescent lighting, motors, and similar equipment in the building. An example of the fluctuations and waveform distortion in a classroom at Empire School is shown in Figure 10 for comparison with Figure 9.

Total harmonic distortion percentages for the different locations at Mary Johnston and Empire Schools are listed in Tables 3 and 4. These measurements show that the magnetic field produced by the transmission and distribution lines at Mary Johnston School is within the normal industry range for THD (typically less than 1% for transmission lines and less than 5% for Distribution lines), and has the lowest THD of any of the fields measured.

7. ELECTRIC AND MAGNETIC FIELD GUIDELINES

A number of different criteria exist for deciding on appropriate electric and magnetic field limits for occupied areas. Since selection of differing criteria will naturally lead to differing field limits, it is not surprising that a range of existing or proposed guidelines for maximum levels of power-frequency electric and magnetic fields may be found.

Guidelines have been implemented in some areas to limit power-line electric fields to as low as 1 kV/m at the edge of a right-of-way. This level would place moderate constraints on some existing North American transmission line design practices. The World Health Organization, in an unpublished evaluation of scientific and medical information, has concluded that no limit to intermittent exposure below 10 kV/m is required but suggests that long-term exposure to fields above 1 kV/m should be as low as reasonably achievable.

Power-frequency magnetic fields have generated some spirited controversies but at the present time no basis appears to exist for formulating guidelines anywhere near the levels encountered in this study. For example, the World Health Organization has concluded in a second study that the threshold for the onset of any effect of power-frequency magnetic fields on biological functions is probably around 500 μT.

8. CONCLUSIONS

At the request of the Waterloo County School Board and in cooperation with the Board and other interested parties, power-frequency electric and/or magnetic fields have been measured at two Public Schools in the Waterloo area. Mary Johnston Public School is adjacent to a double-circuit 115-kV transmission line and a 13.8-kV distribution line. Empire Public School has only local low-voltage feeder lines in the vicinity. The findings from this study are as follows:

The electric field produced by the power lines at Mary Johnston School is 0.2 kV/m at the edge of the school property, and falls off rapidly as one moves across the property. There is no significant electric field produced inside the school building by the power lines.

The magnetic field produced by the power lines at Mary Johnston School is 0.6 μT at the edge of the school property and again falls off rapidly. The highest value produced by the power lines inside the school building is 0.18 μT at the south wall.

Power-frequency electric and magnetic fields exist in all buildings that are connected to the electrical supply. The usual building environment consists of variable and moderately distorted fields with localized areas of relatively high field strength near electrical wiring, equipment, and appliances. Magnetic fields measured in the two schools from inside and outside wiring combined are very similar except for localized areas affected by internal wiring differences. All fields are well below all existing or proposed guidelines and are within the typical ranges expected for buildings of this type.

The transmission and distribution lines adjacent to Mary Johnston School are not a significant source of unusual amplitude or waveform variations. As a corollary, measurement of the RMS field strength is an adequate description of these power-line fields.

In the schools measured, the proximity of a transmission line is not a significant factor in determining the range or the complexity of the magnetic field environment.

Approved:

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Electrical Research Department

Submitted:

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Engineer/Physicist
Science Section

REFERENCES

1. IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines. American National Standard ANSI/IEEE Std 644-1987.

2. A useful review paper is Human Exposure to Static and Time-Varying magnetic fields by Maria A. Stuchly. Health Physics, Vol 51, No 2, pp 215-225, August, 1986. Other references are given below.

3. Measurements of Electric and Magnetic Fields In and Around Homes Near a 500-kV Transmission Line. R. J. Caola, Jr., D. W. Deno, and V. S. W. Dymek. IEEE Transactions on Power Apparatus and Systems, Vol PAS-102, No 10, pp 3338-3347, October, 1983. The living area values used in Table 2 are for houses not close to a transmission line.

4. Toronto area data are unpublished measurements made by Ontario Hydro Research Division.

5. Household Appliance Magnetic Field Survey. J. R. Gauger. IEEE Transactions on Power Apparatus and Systems, Vol PAS-104, No 9, pp 2436-2444, September, 1985.

TABLE I

RMS Electric (E) and Magnetic (H) Field Strengths Measured in the Vicinity of Mary Johnston Public School on June 25, 1987. Location References are in Figure 2

Location		E-Field	H-Field
1. Under power line:	south side	0.98 kV/m	
	center	1.10	1.08 μT
	north side	1.00	
2. Edge of right-of-way		0.20	0.59
3. Under 13.8-kV line		0.09	0.45
4. 1 m outside south wall		0.009	0.23
5. 1 m inside south wall		<0.001	0.18
6. Center of gymnasium		0.001	0.09
7. Kindergarten room		<0.001	<0.02
8. North yard, 25 m from school		0.006	<0.02
9. Center of playing field		0.019	0.05
10. Next to tower:	south side	0.27	
	center	0.18	0.72
	north side	0.16	

NOTE: The < symbol means that the field is less than the value listed.

TABLE 2

RMS Electric (E) and Magnetic (H) Field Strengths
Measured in various Buildings for Comparison with Table 1/2/.

Location	E-Field	H-Field
Living areas of some New Jersey Homes/3/	0 to 0.024 kV/m	0.15 μT
Toronto Area Home #1 (No appliances)/4/	-	0.1 to 0.3
Toronto Area Home #2 (No appliances)	-	0.05 to 1.0
Toronto Area Institutional Building	-	2 to 5
Various Appliances/3/5/ (at 0.3 m)	0.002 to 0.130	0 to 30
Mary Johnston School (0.3 m from electrical outlet)	0.050	-
Mary Johnston School (0.4 m from power tool)	-	2.25

TABLE 3

RMS Magnetic Field Strengths and Total Harmonic Distortion Measured at Mary Johnston School on August 17th, 1987. Location References are in Figure 5

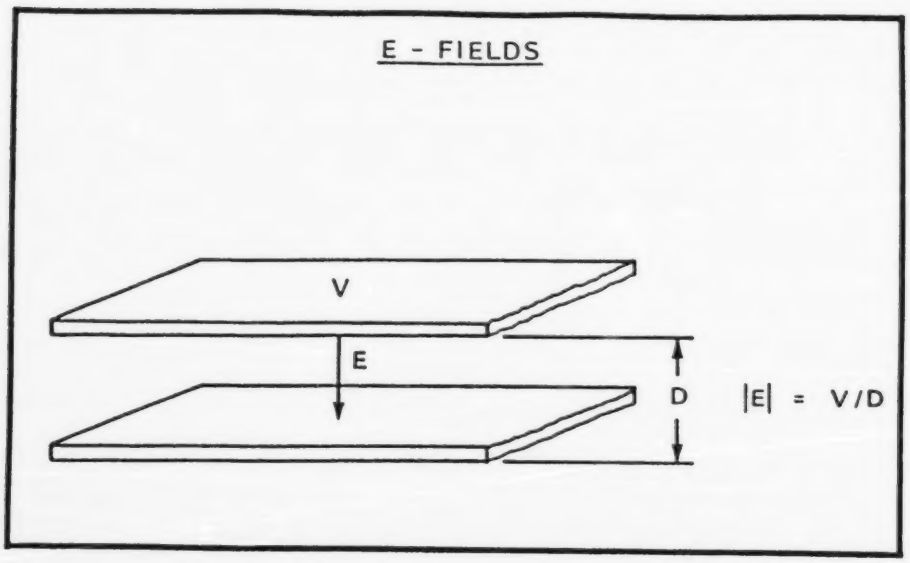
	Location	Field Strength	THD
1.	Edge of right-of-way	0.54 μT	1.9%
2.	Outside-Near South Wall	0.19	4.9
3.	Corridor-Near South end	1.4	3.3
4.	Corridor-Outside Office	1.9	3.5
5.	Centre of Office	0.11	34
6.	Centre of Music Room	0.17	65
7.	Centre of Kindergarten Room	0.02	10
8.	Edge of Playing Field	0.06	5.2

TABLE 4

RMS Magnetic Field Strengths and Total Harmonic Distortion Measured at Empire School on August 18th, 1987. Location References are in Figure 6

Location		Field Strength	THD
1.	Sidewalk South of Dropwires	0.70 μT	-
2.	Sidewalk North of Dropwires	0.60	-
3.	Centre of Kindergarten Room	0.10	29%
4.	East Side of Kindergarten	0.27	66
5.	Lobby	0.23	9.8
6.	Inside Library Entrance	0.29	10
7.	Corridor near Classroom 9	0.30	20
8.	Centre of Classroom 3	0.05	11
9.	Centre of Classroom 6	0.03	49
10.	Playing Field	0.01	100

(A)



(B)

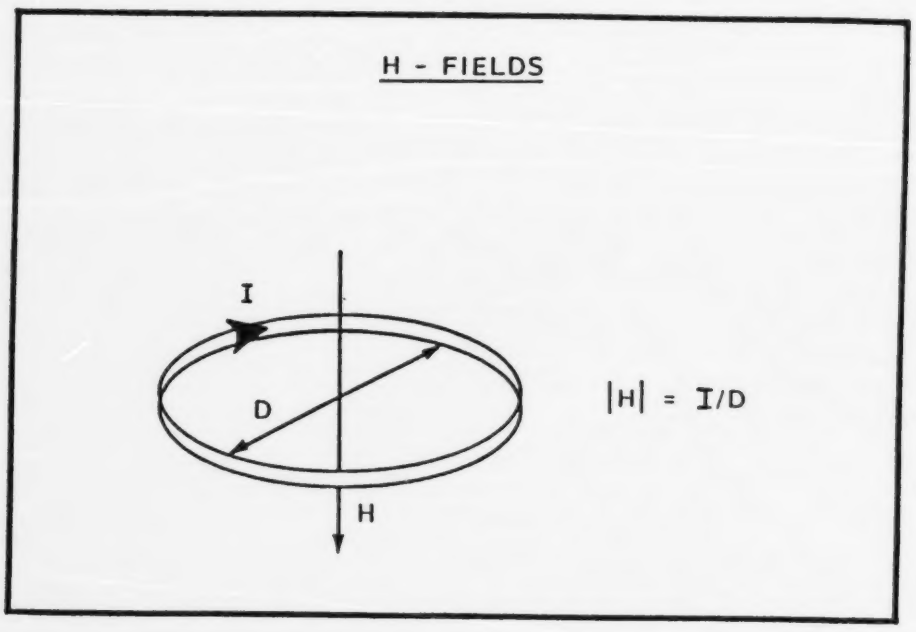


FIGURE 1
SOURCES AND DEFINITIONS FOR ELECTRIC AND MAGNETIC FIELDS
(A) ELECTRIC FIELDS
(B) MAGNETIC FIELDS

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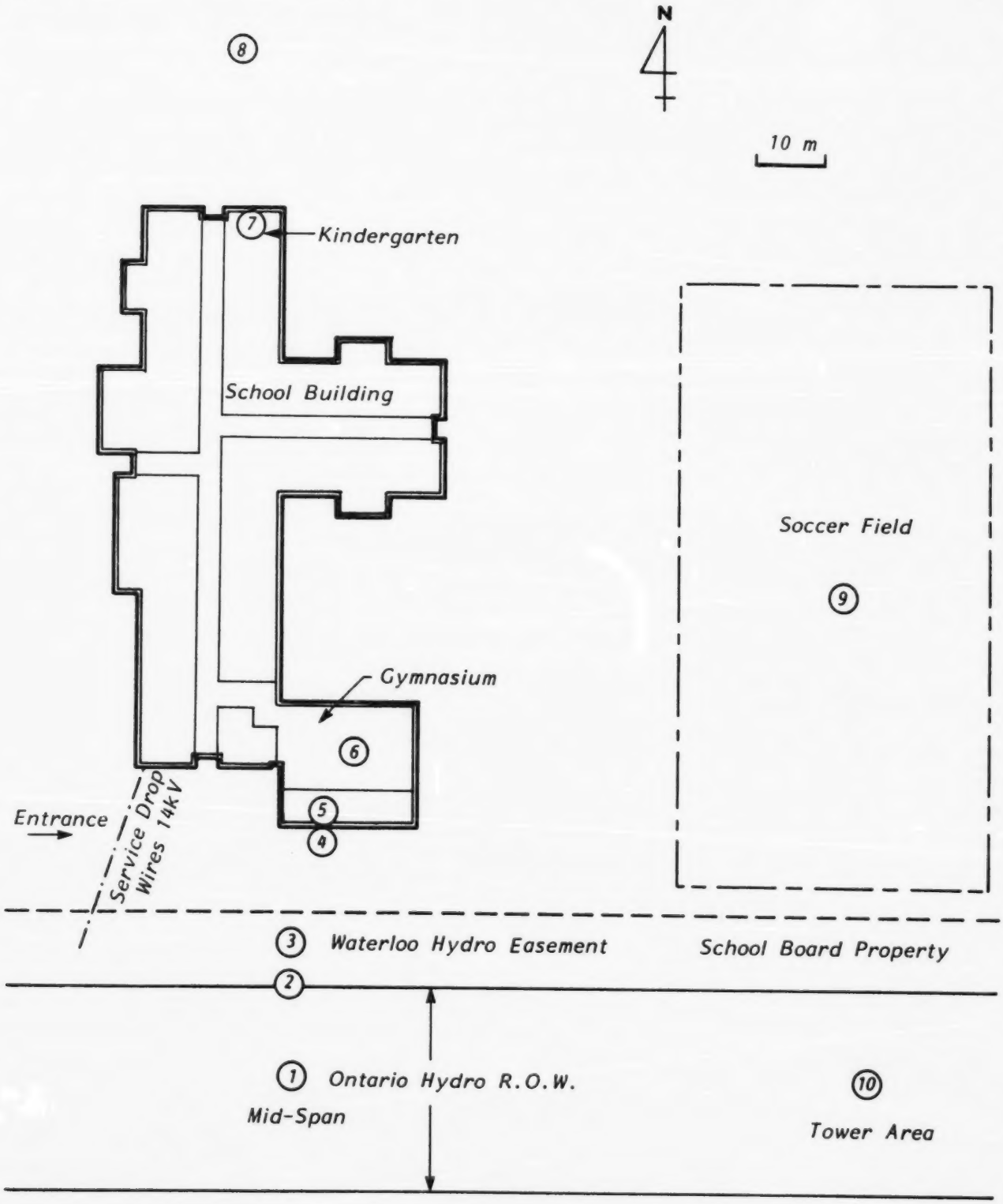


FIGURE 2
LOCATIONS FOR JUNE 25th MEASUREMENTS AT MARY JOHNSTON SCHOOL

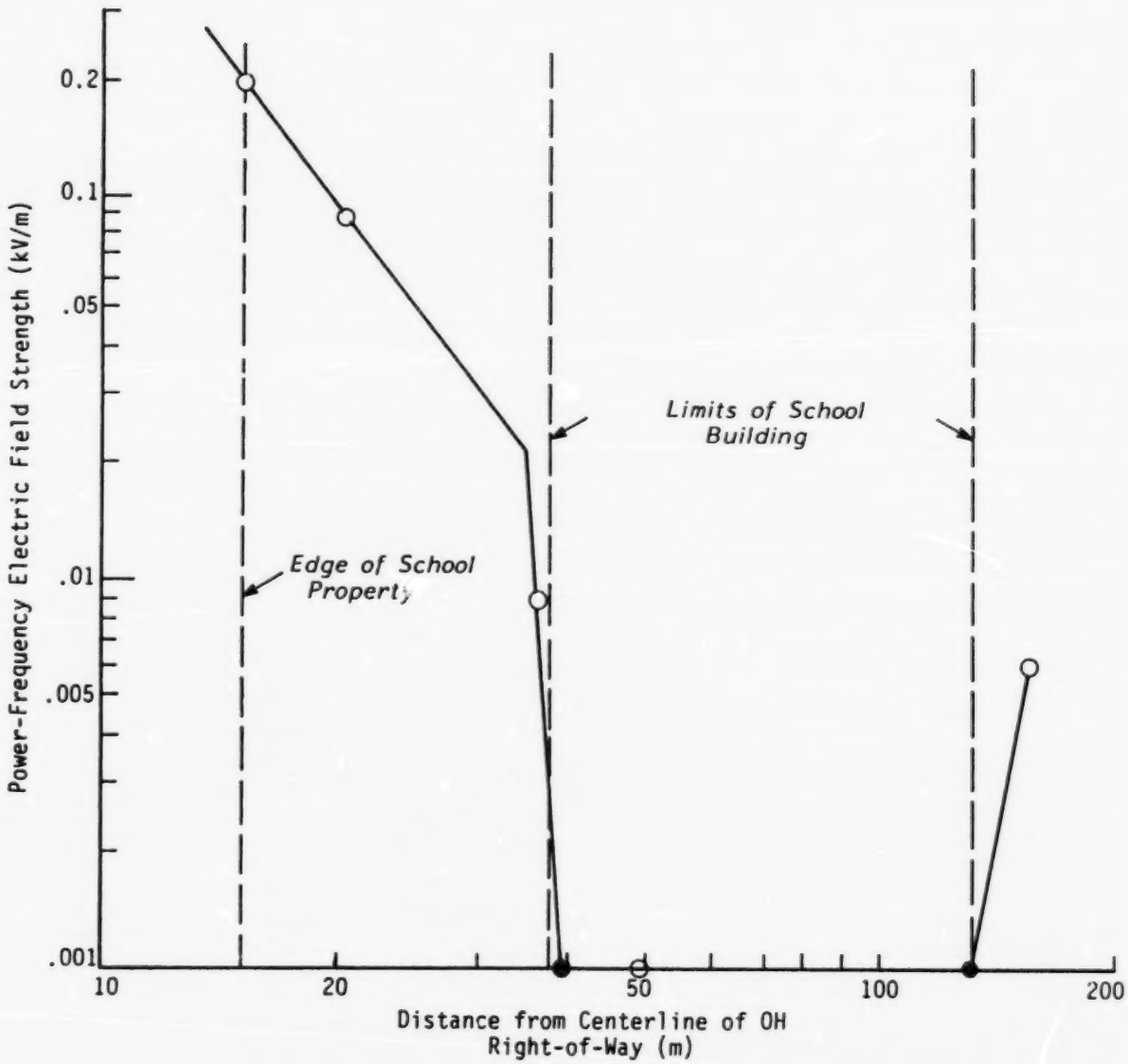


FIGURE 3
ELECTRIC FIELD STRENGTHS ALONG A LINE THROUGH MARY JOHNSTON SCHOOL - JUNE 25th MEASUREMENTS
(SOLID CIRCLES INDICATE READINGS BELOW 0.001 kV/m)

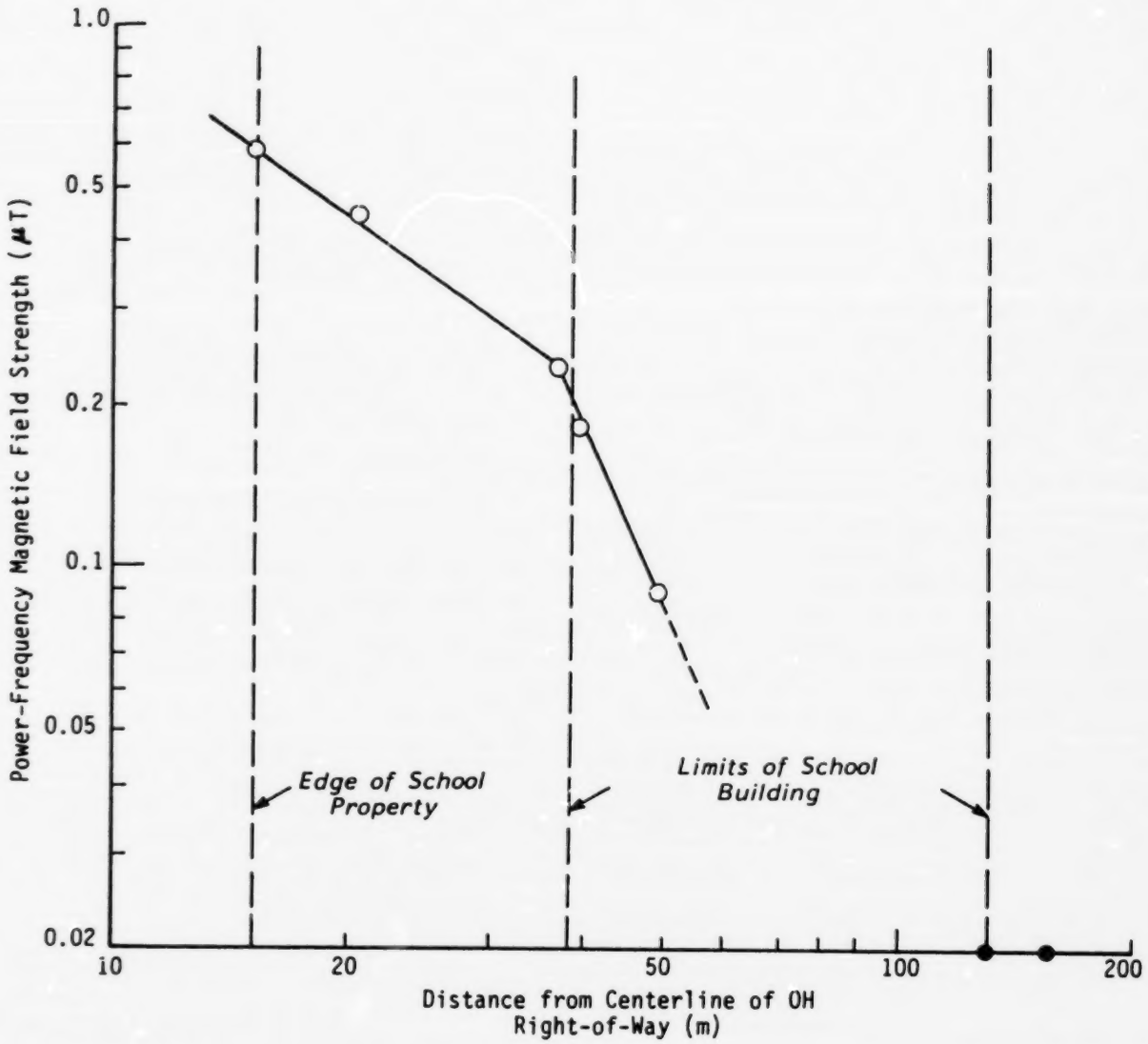


FIGURE 4

MAGNETIC FIELD STRENGTHS ALONG A LINE THROUGH MARY JOHNSTON SCHOOL - JUNE 25th MEASUREMENTS
(SOLID CIRCLES INDICATE READINGS BELOW 0.02 μT)

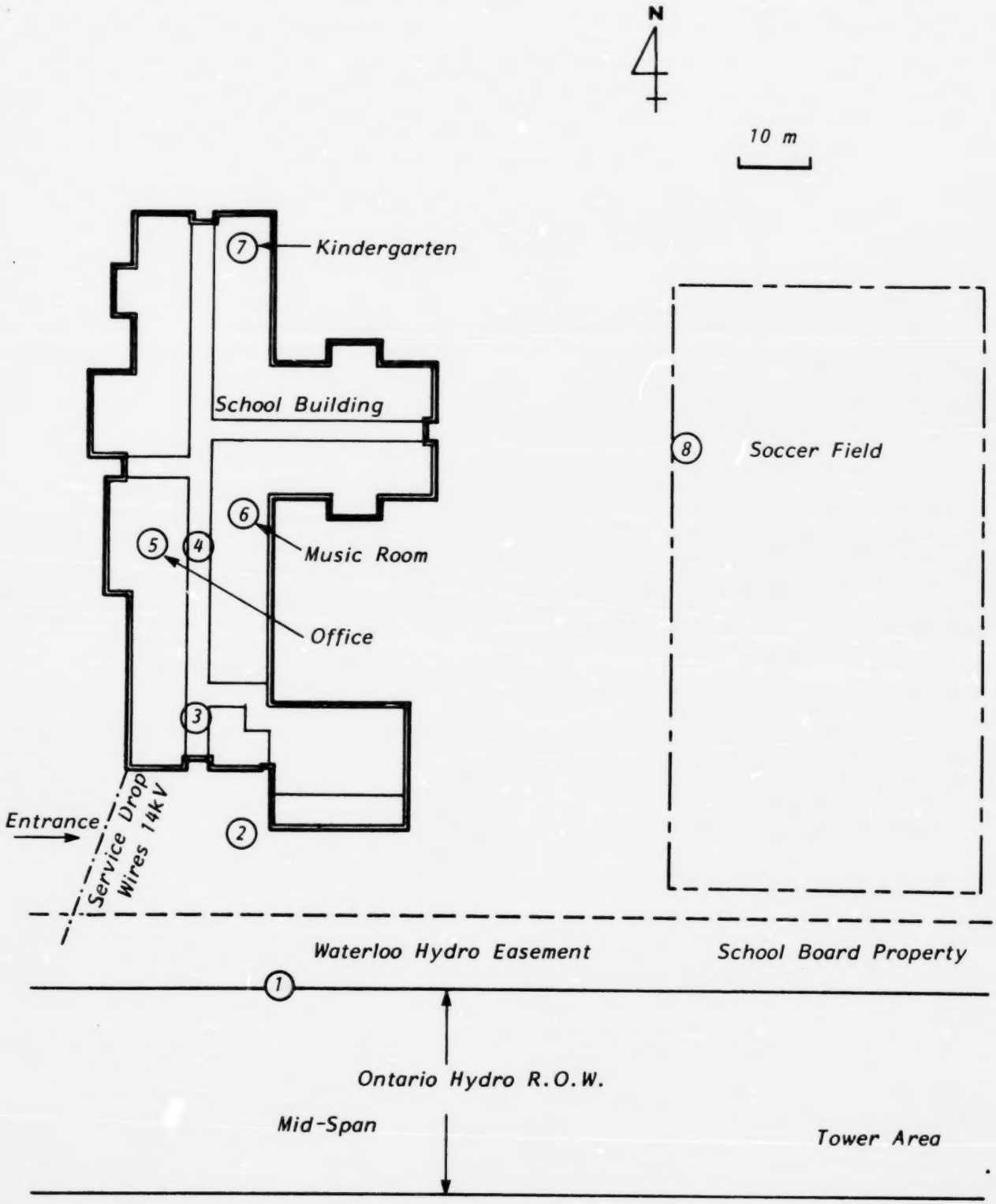


FIGURE 5
LOCATIONS FOR AUGUST 17th MEASUREMENTS AT MARY JOHNSTON SCHOOL

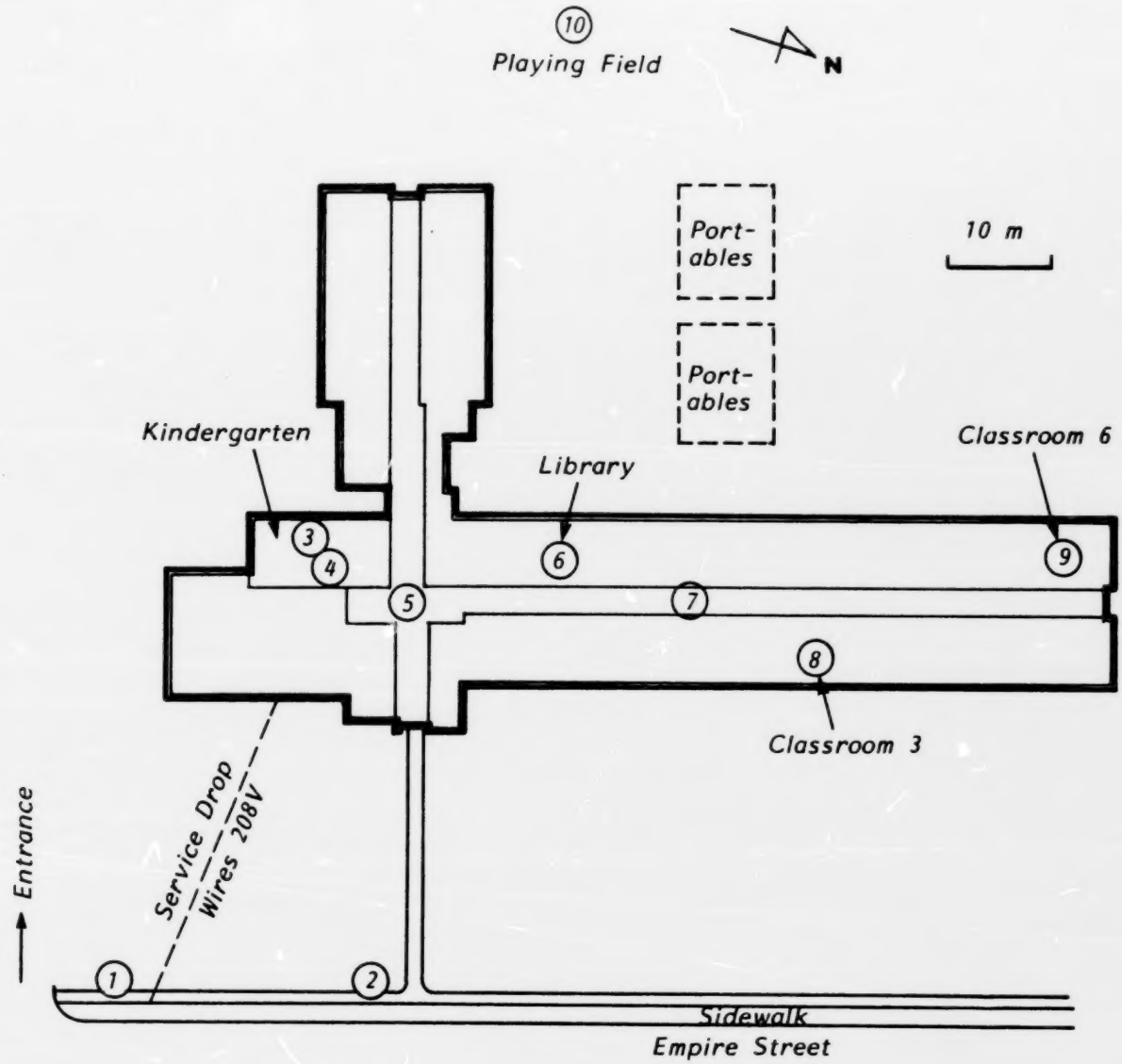
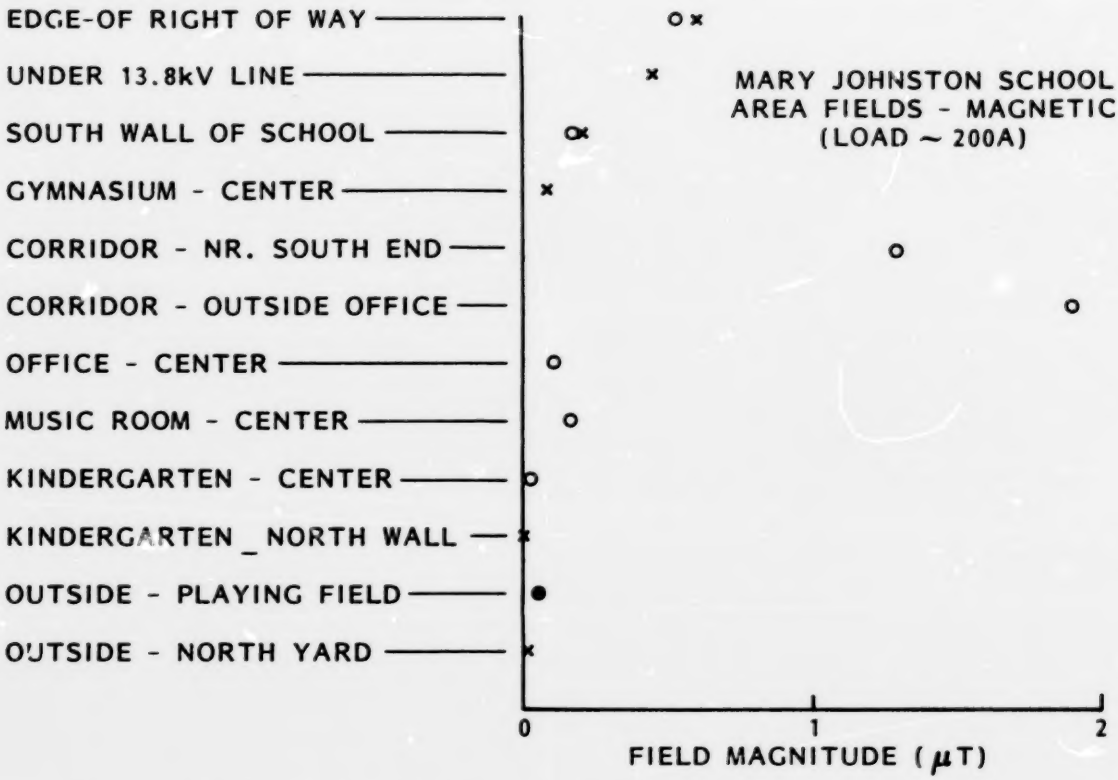


FIGURE 6

LOCATIONS FOR AUGUST 18th MEASUREMENTS AT EMPIRE SCHOOL



NOTE: × DENOTES JUNE 25th MEASUREMENTS

FIGURE 7

MAGNETIC FIELD PROFILE FOR MARY JOHNSTON SCHOOL
INCLUDING INTERNAL WIRING

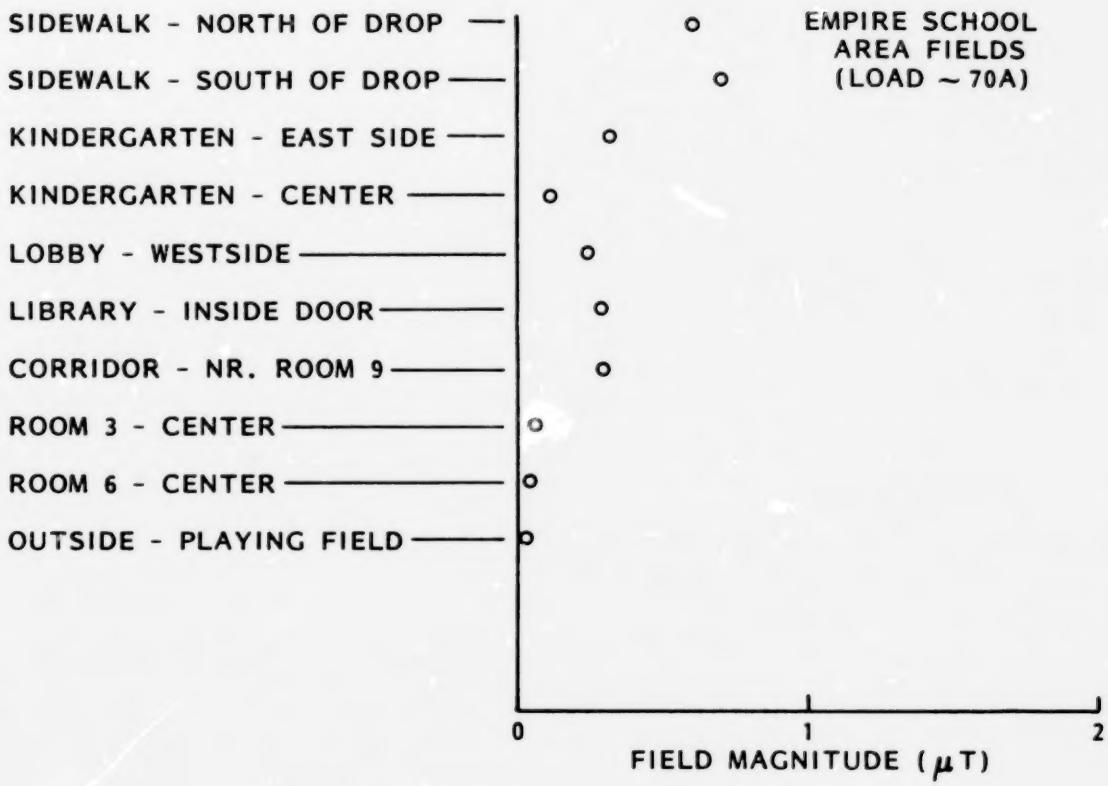
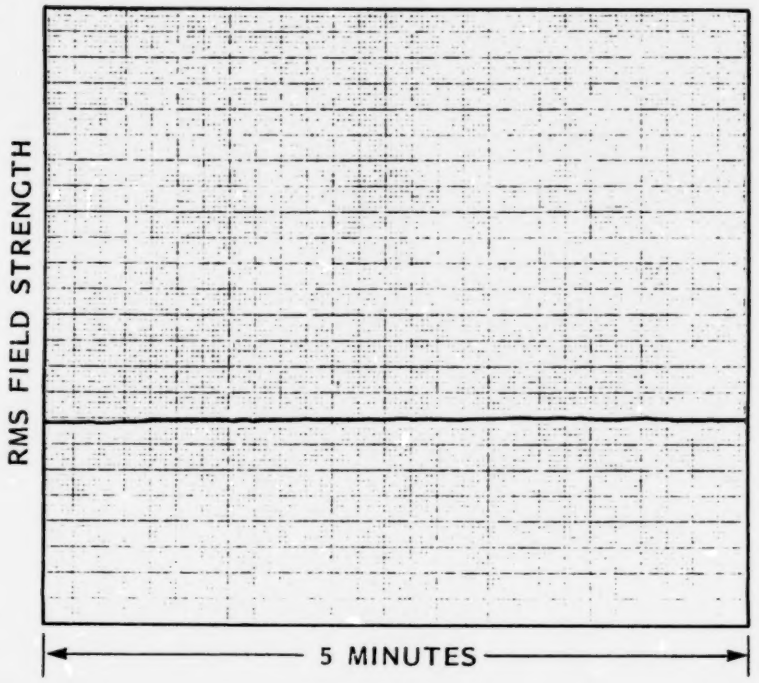
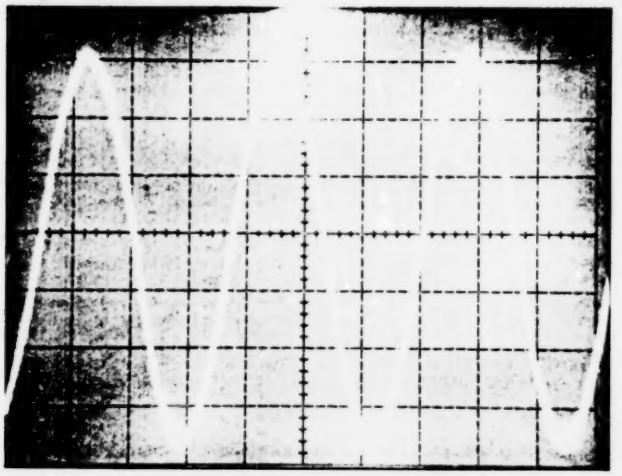


FIGURE 8
MAGNETIC FIELD PROFILE FOR EMPIRE SCHOOL INCLUDING INTERNAL WIRING



A. CONSTANCY OF FIELD



B. SAMPLE WAVE FORM

FIGURE 9

TIME DEPENDENCE OF MAGNETIC FIELDS AT EDGE OF ONTARIO HYDRO RIGHT-OF-WAY

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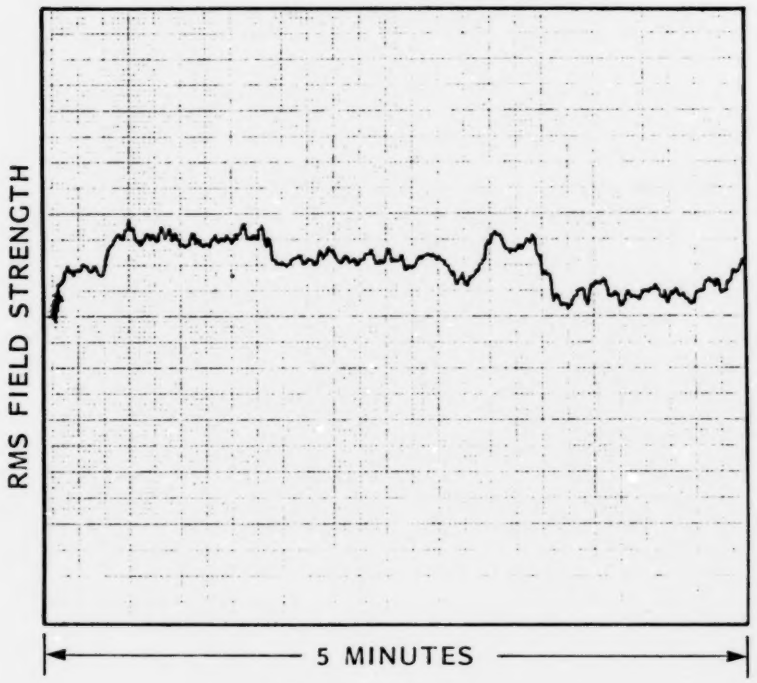
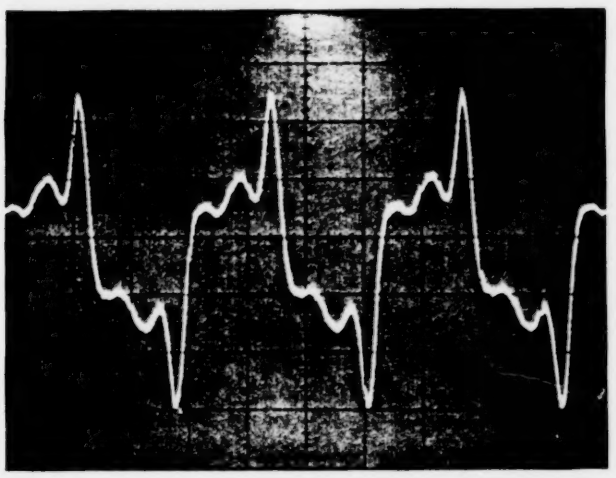


A. CONSTANCY OF FIELD



B. SAMPLE WAVE FORM

FIGURE 10
TIME DEPENDENCE OF MAGNETIC FIELDS IN
EMPIRE SCHOOL CLASSROOM NO. 6

175642-RD

APPENDIX

Listing of Magnetic Field Values Recorded on site by Dr. D. Nobes

The attached tables were kindly prepared by Dr. Nobes from notes taken during the surveys of August 17th and 18th.

In these tables, RMS readings are obtained either with the Ontario Hydro coil and Beckman multimeter or with the hand-held Model 42A exploratory milligaussmeter, and peak-to-peak readings are obtained visually from the oscilloscope displays. RMS calculated values are 35% of peak-to-peak readings.

TABLE 1

Mary Johnston School: Magnetic Field Measurements
17 August 1987 RMS and Peak-to-peak Data

NOTE: All readings at 1 m height, unless otherwise noted.

Location	RMS Reading (μT)	RMS Calc. (μT)	Peak to Peak (μT)	Comments
Outside School:				
Under power line	1.08*			
Under power tower	0.72*			
Right-of-way edge	0.585*	0.530	1.500	
Under 14kV line	0.450*			
1 m S of S wall	0.225*			
2.65 m W of S wall		0.170	0.477	Near line into school.
Playing field edge (near school)	0.07	0.050	0.153	5 m N of line of wall S of asphalt play area.
Playing field	0.045*			Centre.
25 m N of N wall	<0.02*			
* Readings taken 25 June 1987, before power on.				
Inside School:				
Main Entryway	1.60	1.400	4.050	9 m from door, 1 m from wall near power conduit
Outside Office	2.00	2.300	6.480	1 m from power panel.
Inside Office	0.25	0.115	0.324	In front of secr. desk.
	0.40			0.5 m from typewriter.
	0.2 to 0.3			0.5 m from VDT.
Music Room	0.17	0.194	0.594	Centre, above power conduit.
Kindergarten	0.02	0.022	0.063	Centre. Lights off.
		0.0185	0.050	Centre. Lights on.
	0.03			Near outside wall.
End Classroom	0.03			Opposite Kindergarten.

TABLE 2

Empire Public School: Magnetic Field Measurements
18 August 1987 RMS and Peak-to-peak Data

Location	RMS Reading (μT)	RMS Calc. (μT)	Peak to Peak (μT)	Comments
Outside School:				
Playing field	0.015	0.014	0.0405	16 m from W wall, near 1st base.
Inside School:				
Gym, centre	0.30			Near power conduit.
Front lobby	0.20	0.190	0.670	Centre.
Kindergarten	0.19			North centre.
	0.23	0.320	0.900	Block play area, 1 m from wall (E centre).
	0.15			SE corner.
	0.16			SW corner.
	0.09	0.140	0.387	Centre.
Library	0.31	0.300	0.855	1 m inside main doors.
	0.17			Centre.
NS corridor	0.32			Half way down (near power panel).
	0.45	0.300	0.880	1 m from door of #9 classroom.
EW corridor	0.11			Centre, half way down.
Classroom #3	0.063	0.048	0.135	Centre.
	0.082			Head height (about 2 m).
Classroom #14	0.035			Centre.
Classroom #15	0.030			Centre.
Classroom #6	0.028	0.044	0.120	Centre.

TABLE 3 Part 1

Mary Johnston School: Magnetic Field Measurements
17 August 1987 Spectral Harmonic Data

NOTE: Any frequencies besides those noted had amplitudes <0.00045 μT.

Locations: Outside School (Field amplitudes in μT)

Frequency (hz)	Right-of-way (Edge)	Near S wall (Corner)	Edge of Playing Field
60	0.5220	0.2106	0.0509
180	0.0080	0.0091	0.0023
300	0.0046	0.0030	0.0008
420	0.0027	0.0017	0.0006
540	0.0021	0.0032	0.0009

TABLE 3 - Part 2

Mary Johnston School: Magnetic Field Measurements
17 August 1987 Spectral Harmonic Data

Locations: Inside School (Field amplitudes in μT)

Frequency (hz)	Main Entry	Outside Office	Inside Office	Music Room	Kindergarten Lights On	Kindergarten Lights Off
60	0.9945	1.6470	0.0918	0.1580	0.0185	0.0243
120	0.0025	0.0102	0.0055	0.0006		
180	0.4680	0.6885	0.0300	0.1022		0.0023
240	0.0012	0.0018	0.0015			
300	0.0175	0.0251	0.0031	0.0006	0.0017	0.0008
360	0.0015	0.0014	0.0008			
420	0.0086	0.0254	0.0023	0.0041		0.0011
540	0.0234	0.0386	0.0018	0.0059	0.0005	
660	0.0014					
780	0.0005					
900	0.0106	0.0176	0.0007	0.0032		
1020	0.0010	0.0021				
1080		0.0005				
1140	0.0010	0.0015				
1260	0.0055	0.0096		0.0018		
1380		0.0005				
1500		0.0005				
1620	0.0025	0.0038		0.0008		
1980		0.0010				
2340		0.0005				

TABLE 4 - Part 1

Empire Public School: Magnetic Field Measurements
18 August 1987 Spectral Harmonic Data

Locations: Kindergarten (Field amplitudes in μT)

Frequency (hz)	E Centre (Block play area) Heaters On / Off		Centre
50	0.0007	0.0007	
60	0.2057	0.2525	0.0981
70	0.0005		
90		0.0005	
120	0.0018	0.0009	
170		0.0005	
180	0.1337	0.1373	0.0271
190		0.0005	
240	0.0009	0.0009	
300	0.0162	0.0176	0.0086
360	0.0007	0.0007	
420	0.0042	0.0055	0.0007
480		0.0006	
540	0.0084	0.0081	0.0021
660	0.0035	0.0033	0.0009
780	0.0017	0.0018	
900	0.0026	0.0027	0.0005
1020	0.0017	0.0017	
1140	0.0014	0.0015	

TABLE 4 - Part 2

Empire Public School: Magnetic Field Measurements
18 August 1987 Spectral Harmonic Data

Locations: Remainder of Data (incl. outside) (Fields in μT)

Frequency (hz)	Main Hall	Library (1 m inside door)	Outside Class #9	Centre Class #3	Centre Class #6	Playing Field
60	0.2246	0.2813	0.2867	0.0450	0.0284	0.0073
180	0.0217	0.0189	0.0518	0.0022	0.0098	0.0063
300	0.0030	0.0203	0.0182	0.0045	0.0090	0.0044
420	0.0029	0.0074	0.0110	0.0011	0.0042	0.0021
540	0.0006	0.0033	0.0044	0.0006	0.0017	0.0008
660		0.0020	0.0027		0.0005	
780		0.0012	0.0023			
900		0.0008	0.0009			
1020		0.0006	0.0010			
1140			0.0007			

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